STRUKTUR BAJA 1

MODUL 4

Sesi 2

Batang Tekan (*Compression Member*)

Materi Pembelajaran : LATIHAN 1 / Workshop.

1. Menghitung angka kekakuan batang.
2. Membaca nomogram faktor panjang tekuk.
3. Menghitung panjang tekuk.
4. Menghitung angka kelangsingan sayap dan badan.
5. Menghitung angka kelangsingan batang.
6. Menghitung kekuatan nominal terfaktor batang tekan.

Tujuan Pembelajaran :

Mahasiswa dapat menghitung angka kekakuan batang, membaca nomogram faktor panjang tekuk, menghitung panjang tekuk, menghitung angka kelangsingan sayap dan badan, menghitung angka kelangsingan batang tekan dan menghitung kekuatan nominal terfaktor batang tekan.

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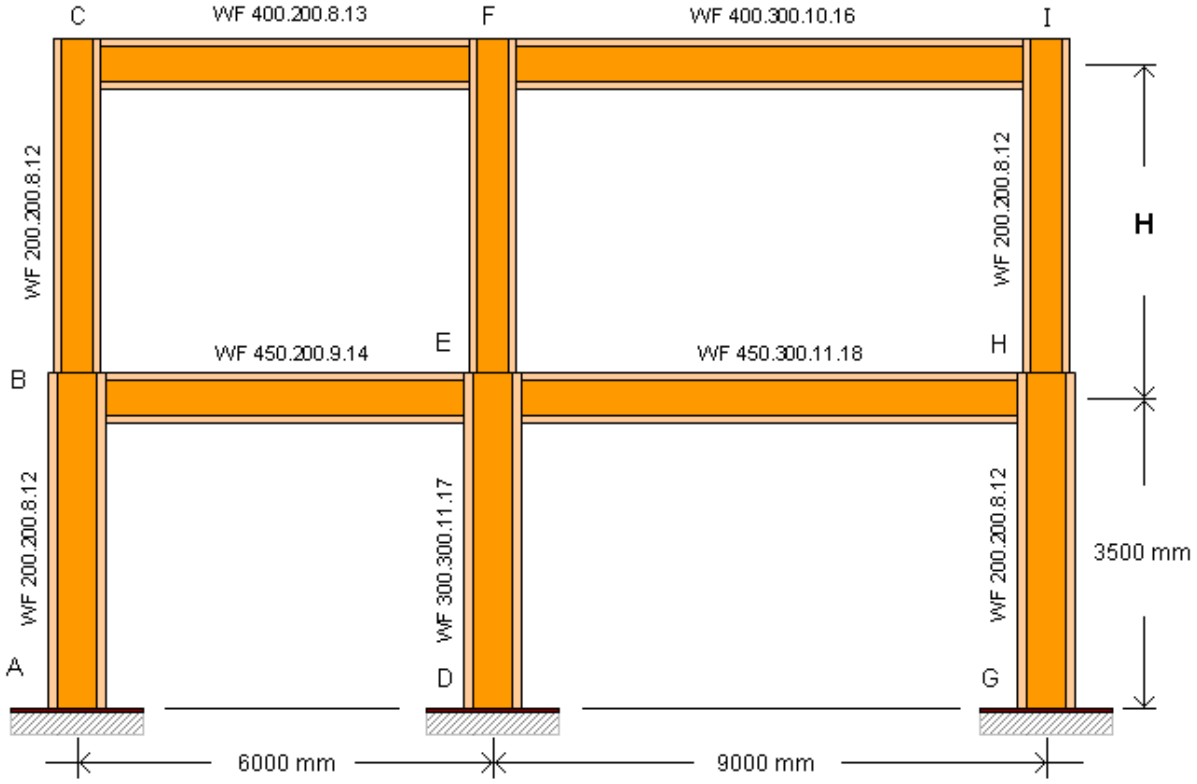
f) William T. Segui,"*Steel Design*", THOMSON, 2007.

B A T A N G T E K A N

(COMPRESSSION MEMBER)

PELATIHAN / WORKSHOP 1



Gambar 16 : Bangunan Portal Baja.

Diketahui : Struktur portal seperti tergambar. Ukuran profil kolom E – F dan tinggi tingkat H lihat data soal. Mutu baja BJ-34. Data lain lihat tabel terlampir.

Diminta : Lakukan evaluasi terhadap kolom E – F tersebut.

Penyelesaian :

a). Data-data,

- Balok C – F, WF 400.200.8.13, $Ix = 23700$ cm^4.
- Balok F – I, WF 400.300.10.16, $Ix = 38700$ cm^4.
- Balok B – E, WF 450.200.9.14, $Ix = 33500$ cm^4.
- Balok E – H, WF 450.300.11.18, $Ix = 56100$ cm^4.
- Kolom D – E, WF 300.300.11.17, $Ix = 23400$ cm^4.
- Kolom E – F, WF 250.125.6.9, $Ix = 4050$ cm^4, $Iy = 294$ cm^4. (yang lain lihat soal)

b). Kekakuan elemen portal.

- Balok C – F, Ix/L = 23700 / 600 = 39,500 cm^3.
- Balok F – I, Ix/L = 38700 / 900 = 43,000 cm^3.
- Balok B – E, Ix/L = 33500 / 600 = 55,833 cm^3.
- Balok E – H, Ix/L = 56100 / 900 = 62,333 cm^3.
- Kolom D – E, Ix/L = 23400 / 350 = 66,857 cm^3.
- Kolom E – F, Ix / L = 4050 / 300 = 13,500 cm^4. (yang lain lihat soal)

c).Faktor panjang tekuk.

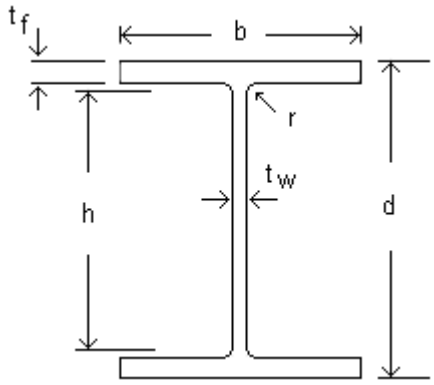
$$G_F = \frac{\text{Kolom } E-F}{\text{Balok } C-F + \text{Balok } F-I} = \frac{13{,}500}{39{,}500 + 43{,}000} = 0{,}16$$

$$G_E = \frac{\text{Kolom } E-F + \text{Kolom } E-D}{\text{Balok } B-E + \text{Balok } E-H} = \frac{13{,}500 + 66{,}857}{55{,}833 + 62{,}333} = 0{,}68$$

Dari nomogram diperoleh faktor panjang tekuk, $k = 1{,}12$

DATA-DATA :
WF 250.125.6.9

d	=	250	mm
b	=	125	mm
t_f	=	9	mm
t_w	=	6	mm
L	=	3000	mm
r	=	12	mm
Ag	=	3766	mm^2
r_x	=	104	mm
r_y	=	27,9	mm
h	=	d - 2.(t_f + r)	
	=	250 – 2 . (9 + 12)	
h	=	208	mm



Gambar 17.

E V A L U A S I

a. **Kelangsingan batang**.

Faktor panjang tekuk, $k = 1{,}12$

- Tekuk ke arah sumbu – X,

$$L_{kx} = k \,.\, L = 1{,}12 \,.\, (3000) = 3360 \text{ mm.}$$

$$\lambda_x = \frac{L_{kx}}{r_x} = \frac{3360}{104} = 32{,}31 < 200 \text{ (memenuhi).}$$

- Tekuk ke arah sumbu – Y,

$$L_{ky} = k \,.\, L = 1{,}12 \,.\, (3000) = 3360 \text{ mm.}$$

$$\lambda_y = \frac{L_{ky}}{r_y} = \frac{3360}{27{,}9} = 120{,}43 < 200 \text{ (memenuhi).}$$

b. **Kekuatan nominal terfaktor batang tekan**.

- Ke arah sumbu – X,

$$\lambda_{cx} = \frac{1}{\pi}\frac{L_{kx}}{r_x}\sqrt{\frac{fy}{E}}$$

$$\lambda_{cx} = \frac{1}{\pi}.(32{,}31).\sqrt{\frac{210}{200000}} = 0{,}3334 \quad (\text{untuk } \pi = 3{,}14)$$

Untuk $0{,}25 < \lambda_{cx} < 1{,}2$ maka $\omega_x = \dfrac{1{,}43}{1{,}6 - 0{,}67\lambda_{cx}}$

$$\omega_x = \frac{1{,}43}{1{,}6 - 0{,}67\,.\,(0{,}3334)} = 1{,}0388$$

Kekuatan nominal batang tekan,

$$N_n = Ag \,.\, f_{cr} = Ag \,.\, \frac{fy}{\omega_x} = (3766\,\text{mm}).\frac{210\,\text{MPa}}{1{,}0388} = 761320{,}8\,N$$

$$N_n = 761{,}3\ kN\,.$$

Kekuatan nominal terfaktor,

$$N_u = \phi n \,.\, N_n = 0{,}85 \,.\, (761{,}3)\ kN = 647{,}1\ kN.$$

- **Ke arah sumbu – Y**,

$$\lambda_{cy} = \frac{1}{\pi}\frac{L_{ky}}{r_y}\sqrt{\frac{fy}{E}}$$

$$\lambda_{cy} = \frac{1}{\pi}.(120{,}43).\sqrt{\frac{210}{200000}} = 1{,}2428 \quad (\text{untuk } \pi = 3{,}14)$$

Untuk $\lambda_c \geq 1{,}2$ maka $\omega = 1{,}25\lambda_c^2$

$$\omega_y = 1{,}25 \,.\, (1{,}2428)^2 = 1{,}9307$$

Kekuatan nominal batang tekan,

$$N_n = Ag \,.\, f_{cr} = Ag \,.\, \frac{fy}{\omega_y} = (3766\,\text{mm}).\frac{210\,\text{MPa}}{1{,}9307} = 409627{,}8\,N$$

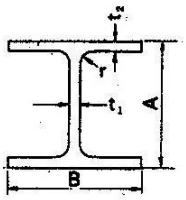
$$N_n = 409{,}6\ kN\,.$$

Kekuatan nominal terfaktor,

$$N_u = \phi n \,.\, N_n = 0{,}85 \,.\, (409{,}6)\ kN = 348{,}2\ kN.$$

BJ-34															
		fy =	210	Mpa											
No. Stb.	KOLOM E - F	*Ix* cm^4	*H* cm	*Ix / L* cm^3	G_F	G_E	*k*	*Lk* mm	d mm	b mm	tw mm	tf mm	r mm	*A*g cm2	*Iy* cm4
	WF 250.125.6.9	4050	300	13.500	0.16	0.68	1.12	3360	250	125	6	9	12	37.66	294
0	WF 250.175.7.11	6120	310	19.742	0.24	0.73	1.15	3565	244	175	7	11	16	56.24	984
1	WF 250.250.11.11	8790	320	27.469	0.33	0.80	1.17	3744	244	252	11	11	16	82.06	2940
2	WF 250.250.8.13	9930	330	30.091	0.36	0.82	1.18	3894	248	249	8	13	16	84.70	3350
3	WF 250.250.9.14	10800	340	31.765	0.39	0.83	1.18	4012	250	250	9	14	16	92.18	3650
4	WF 250.250.14.14	11500	350	32.857	0.40	0.84	1.19	4165	250	250	14	14	16	104.70	3880
5	WF 300.150.6,5.9	7210	360	20.028	0.24	0.74	1.15	4140	300	150	6.5	9	13	46.78	508
6	WF 300.200.8.12	11300	370	30.541	0.37	0.82	1.17	4329	294	200	8	12	18	72.38	1600
7	WF 300.300.12.12	16900	380	44.474	0.54	0.94	1.21	4598	294	302	12	12	18	107.7	5520
8	WF 300.300.9.14	18800	390	48.205	0.58	0.97	1.22	4758	298	299	9	14	18	110.8	6240
9	WF 300.300.10.15	20400	400	51.000	0.62	1.00	1.25	5000	300	300	10	15	18	119.8	6750

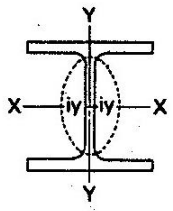
rx = *ix* cm	*ry* = *iy* cm	h mm	λ_x	λ_y	λ_{cx}	ω_x	*N*u kN	λ_{cy}	ω_y	*N*u kN
10.4	2.79	208	32.31	120.43	0.3334	1.0388	647.1	1.2428	1.9307	348.2
10.4	4.18	190	34.28	85.29	0.3537	1.0492	956.8	0.8801	1.4154	709.3
10.3	5.98	190	36.35	62.61	0.3751	1.0603	1381.5	0.6461	1.2252	1195.5
10.8	6.29	190	36.06	61.91	0.3721	1.0587	1428.1	0.6389	1.2202	1239.1
10.8	6.29	190	37.15	63.78	0.3834	1.0647	1545.5	0.6582	1.2338	1333.6
10.5	6.09	190	39.67	68.39	0.4093	1.0786	1732.6	0.7058	1.2687	1473.1
12.4	3.29	256	33.39	125.84	0.3445	1.0444	799.5	1.2986	2.1079	396.1
12.5	4.71	234	34.63	91.91	0.3574	1.0510	1229.2	0.9485	1.4826	871.4
12.5	7.16	234	36.78	64.22	0.3796	1.0627	1809.1	0.6627	1.2370	1554.1
13.0	7.51	234	36.60	63.36	0.3777	1.0617	1862.9	0.6538	1.2307	1607.0
13.1	7.51	234	38.17	66.58	0.3939	1.0703	1998.0	0.6871	1.2547	1704.3



Wide Flange Shapes

(Metric Series)-Continued

Section Index	Weight	Depth of Section (A)	Flange Width (B)	Thickness		Corner Radius (r)	Sectional Area	Moment of Inertia		Radius of Gyration		Modulus of Section	
				Web (t_1)	Flange (t_2)			Jx	Jy	ix	iy	Zx	Zy
mm	kg/m	mm	mm	mm	mm	mm	cm²	cm⁴	cm⁴	cm	cm	cm³	cm³
250×250	82.2	250	255	14	14	16	104.7	11,500	3,880	10.5	6.09	919	304
	72.4	250	250	9	14	16	92.18	10,800	3,650	10.6	6.29	867	292
	66.5	248	249	8	13	16	84.70	9,930	3,350	10.8	6.29	801	269
	64.4	244	252	11	11	16	82.06	8,790	2,940	10.3	5.98	720	233
250×175	44.1	244	175	7	11	16	56.24	6,120	984	10.4	4.18	502	113
250×125	29.6	250	125	6	9	12	37.66	4,050	294	10.4	2.79	324	47.0
	25.7	248	124	5	8	12	32.68	3,540	255	10.4	2.79	285	41.1
200×200	65.7	208	202	10	16	13	83.69	6,530	2,200	8.83	5.13	628	218
	56.2	200	204	12	12	13	71.53	4,980	1,700	8.35	4.88	498	167
	49.9	200	200	8	12	13	63.53	4,720	1,600	8.62	5.02	472	160
200×150	30.6	194	150	6	9	13	39.01	2,690	507	8.30	3.61	277	67.6
200×100	21.3	200	100	5.5	8	11	27.16	1,840	134	8.24	2.22	184	26.8
	18.2	198	99	4.5	7	11	23.18	1,580	114	8.26	2.21	160	23.0
175×175	40.2	175	175	7.5	11	12	51.21	2,880	984	7.50	4.38	330	112
175×125	23.3	169	125	5.5	8	12	29.65	1,530	261	7.18	2.97	181	41.8
175× 90	18.1	175	90	5	8	9	23.04	1,210	97.5	7.26	2.06	139	21.7
150×150	31.5	150	150	7	10	11	40.14	1,640	563	6.39	3.75	219	75.1
150×100	21.1	148	100	6	9	11	26.84	1,020	151	6.17	2.37	138	30.1
150× 75	14.0	150	75	5	7	8	17.85	666	49.5	6.11	1.66	88.8	13.2
125×125	23.8	125	125	6.5	9	10	30.31	847	293	5.29	3.11	136	47.0
125× 60	13.2	125	60	6	8	9	16.84	413	29.2	4.95	1.32	66.1	9.73
100×100	17.2	100	100	6	8	10	21.90	383	134	4.18	2.47	76.5	26.7
100× 50	9.30	100	50	5	7	8	11.85	187	14.8	3.98	1.12	37.5	5.91



Section Index	Weight	Depth of Section (A)	Flange Width (B)	Thickness		Corner Radius (r)	Sectional Area	Moment of Inertia		Radius of Gyration		Modulus of Section	
				Web (t_1)	Flange (t_2)			Jx	Jy	ix	iy	Zx	Zy
mm	kg/m	mm	mm	mm	mm	mm	cm²	cm⁴	cm⁴	cm	cm	cm³	cm³
400×400	200	406	403	16	24	22	254.9	78,000	26,200	17.5	10.1	3,840	1,300
	197	400	408	21	21	22	250.7	70,900	23,800	16.8	9.75	3,540	1,170
	172	400	400	13	21	22	218.7	66,600	22,400	17.5	10.1	3,330	1,120
	168	394	405	18	18	22	214.4	59,700	20,000	16.7	9.65	3,030	985
	147	394	398	11	18	22	186.8	56,100	18,900	17.3	10.1	2,850	951
	140	388	402	15	15	22	178.5	49,000	16,300	16.6	9.54	2,520	809
400×300	107	390	300	10	16	22	136.0	38,700	7,210	16.9	7.28	1,980	481
	94.3	386	299	9	14	22	120.1	33,700	6,240	16.7	7.21	1,740	418
400×200	66.0	400	200	8	13	16	84.12	23,700	1,740	16.8	4.54	1,190	174
	56.6	396	199	7	11	16	72.16	20,000	1,450	16.7	4.48	1,010	145
350×350	159	356	352	14	22	20	202.0	47,600	16,000	15.3	8.90	2,670	909
	156	350	357	19	19	20	198.4	42,800	14,400	14.7	8.53	2,450	809
	136	350	350	12	19	20	173.9	40,300	13,600	15.2	8.84	2,300	776
	131	344	354	16	16	20	166.6	35,300	11,800	14.6	8.43	2,050	669
	115	344	348	10	16	20	146.0	33,300	11,200	15.1	8.78	1,940	646
	106	338	351	13	13	20	135.3	28,200	9,380	14.4	8.33	1,670	534
350×250	79.7	340	250	9	14	20	101.5	21,700	3,650	14.6	6.00	1,280	292
	69.2	336	249	8	12	20	88.15	18,500	3,090	14.5	5.92	1,100	248
350×175	49.6	350	175	7	11	14	63.14	13,600	984	14.7	3.95	775	112
	41.4	346	174	6	9	14	52.68	11,100	792	14.5	3.88	641	91.0
300×300	106	304	301	11	17	18	134.8	23,400	7,730	13.2	7.57	1,540	514
	106	300	305	15	15	18	134.8	21,500	7,100	12.6	7.26	1,440	466
	94.0	300	300	10	15	18	119.8	20,400	6,750	13.1	7.51	1,360	450
	87.0	298	299	9	14	18	110.8	18,800	6,240	13.0	7.51	1,270	417
	84.5	294	302	12	12	18	107.7	16,900	5,520	12.5	7.16	1,150	365
300×200	65.4	298	201	9	14	18	83.36	13,300	1,900	12.6	4.77	893	189
	56.8	294	200	8	12	18	72.38	11,300	1,600	12.5	4.71	771	160
300×150	36.7	300	150	6.5	9	13	46.78	7,210	508	12.4	3.29	481	67.7
	32.0	298	149	5.5	8	13	40.80	6,320	442	12.4	3.29	424	59.3